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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Attorney Docket No. 22-0134

First Inventor or Application Identifier Esmaell Yousefi

Title See 1 in Addendum

Express Mail Label No. EK432677071US

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. ☒ * Fee Transmittal Form (e.g., PTO/SB/17)
 (Submit an original and a duplicate for fee processing)
2. ☒ Specification [Total Pages
 (preferred arrangement set forth below)
- Descriptive title of the invention
 - Cross References to Related Applications
 - Statement Regarding Fed sponsored R & D
 - Reference to Microfiche Appendix
 - Background of the Invention
 - Brief Summary of the Invention
 - Brief Description of the Drawings (if filed)
 - Detailed Description
 - Claim(s)
 - Abstract of the Disclosure
3. ☒ Drawing(s) (35 U.S.C. 113) [Total Sheets

4. Oath or Declaration [Total Pages
 - a. ☐ Newly executed (original or copy)
 - b. ☐ Copy from a prior application (37 C.F.R. § 1.63(d))
 (for continuation/divisional with Box 16 completed)
 - i. ☐ DELETION OF INVENTOR(S)
 Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).

* NOTE FOR ITEMS 1 & 13 IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37 C.F.R. § 1.27), EXCEPT IF ONE FILED IN A PRIOR APPLICATION IS RELIED UPON (37 C.F.R. § 1.28).

ADDRESS TO:

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5. ☐ Microfiche Computer Program (Appendix)
6. Nucleotide and/or Amino Acid Sequence Submission (if applicable, all necessary)
- a. ☐ Computer Readable Copy
 - b. ☐ Paper Copy (identical to computer copy)
 - c. ☐ Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

7. ☐ Assignment Papers (cover sheet & document(s))
8. ☒ 37 C.F.R. § 3.73(b) Statement (when there is an assignee) ☒ Power of Attorney
9. ☐ English Translation Document (if applicable)
10. ☐ Information Disclosure Statement (IDS)/PTO-1449 ☐ Copies of IDS Citations
11. ☐ Preliminary Amendment
12. ☒ Return Receipt Postcard (MPEP 503)
 (Should be specifically itemized)
13. ☐ * Small Entity Statement(s) filed in prior application (PTO/SB/09-12) ☐ Status still proper and desired
14. ☐ Certified Copy of Priority Document(s) (if foreign priority is claimed)
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☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No. _____ / _____

Prior application information: Examiner _____

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17. CORRESPONDENCE ADDRESS

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Inventor: John L. Smith
Title: Beam Laydown for Hopped Satellite Downlink with Adaptable Duty Cycle
(Signature)

TRW Docket No. 22-0134

- 1 -

TITLE OF THE INVENTION

Beam Laydown for Hopped Satellite Downlink with Adaptable Duty Cycle

5

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is related to TRW Docket No. 22-0006, titled "Gated Power Time Division Downlink for a Processing Satellite", filed March 16, 1999 as Serial No. 09/270,361 and TRW Docket No. 22-0127, title "Beam Hopped Gated Power Time Division Downlink", filed _____ as Serial No. _____.

10

BACKGROUND OF THE INVENTION

The present invention relates to satellite communications systems. In particular, the present invention relates to downlink beam power gating techniques particularly adapted to variable hop cycle beam laydowns.

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Satellites have long been used to provide communication capabilities on a global scale. Typically, a satellite includes multiple uplink and downlink antennas, each of which provides
5 communication bandwidth to a large service region using multiple spot beams. The area covered by a spot beam is commonly referred to as a cell, and color coded spot beams are assigned in a pattern called a laydown to cover the cells that make up a service
10 region.

Spot beams are distinguished from one another by such characteristics as frequency or polarization. These characteristics allowed the spot beams in an appropriately designed laydown to operate without
15 substantial cross channel, co-channel, or cross polarization interference. Each spot beam typically provides a fixed amount of bandwidth. Thus, prior laydowns often operated under the constraint that each cell had the same bandwidth allotment as any other
20 cell. To provide additional bandwidth to a cell

- 3 -

therefore meant providing additional spot beams for the cell, a potentially costly and complex proposition.

On the other hand, a laydown may include cells
 5 that simply do not need the bandwidth provided by an entire spot beam. However, prior satellites were incapable of reallocating spot beams to meet bandwidth demand, particularly on a dynamic basis. Thus, a risk exists that, after satellite launch, an increase in
 10 bandwidth demand cannot be met, and that a decrease in bandwidth demand will result in wasted power.

A need has long existed in the industry for a beam laydown that addresses the problems noted above and others previously experienced.

15

BRIEF SUMMARY OF THE INVENTION

A preferred embodiment of the present invention provides a method for generating a variable hop cycle beam laydown. The method includes the steps of

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transmitting first downlink beam energy for first cells according to a first hop cycle. The first hop cycle may be a 50-50 hop cycle that evenly shares bandwidth between two cells, for example. The method
5 also transmits second downlink beam energy for second cells according to a second hop cycle and transmits transition downlink beam energy for transition cells according to a transition hop cycle. The second hop cycle may be, for example, a 75-25 hop cycle that
10 provides more bandwidth for one of the second cells. The transition cells transition the first hop cycle to the second hop cycle. As an example, the transition hop cycle may be a 50-25 hop cycle with power gating 25 percent of the time.

15 The first, second, and transition cells may be pairs of adjacent or non-adjacent cells. However, downlink beams may hop between more than two cells. In addition, the downlink beams are generally separated by frequency and polarization, but may have
20 other distinguishing characteristics.

- 5 -

The variable hop cycle beam laydown manifests itself terrestrially as first cells supported by a first hop cycle, second cells supported by a second hop cycle, and transition cells supported by a transition hop cycle. The transition hop cycle uses power gating to transition the laydown from cells operating at the first hop cycle to cells operating at the second hop cycle. To this end, the transition hop cycle power gates its downlink beam for a portion of time needed to reduce interference between nearby (e.g., adjacent) cells.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a block diagram of a power gating module.

Figure 2 shows a detailed block diagram of a power gating module.

Figure 3 shows a modulator implementation that supports power gating.

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Figure 4 shows a multiple payload frame signal with exemplary power gating control signals.

Figure 5 illustrates operational steps that occur before and after a beam hopping multiple payload frame signal is power gated.

Figure 6 shows a beam laydown using beams of a first frequency and one of two polarizations.

Figure 7 depicts a power gated, variable hop cycle beam laydown.

10

DETAILED DESCRIPTION OF THE INVENTION

Turning now to Figure 1, that figure shows a block diagram of a power gating module 100 that also functions, in general, to generate downlink frame waveforms. The power gating module 100 includes a controller 102 and a waveform processing chain that operates on data provided by the data source 104 (which may be a data memory organized by data queues,

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for example). In particular, the waveform processing chain includes a waveform generator 106, a power amplifier 108, and a switch 110. The waveform processing chain further includes a first feed path
5 112 and a second feed path 114.

The first feed path 112 and the second feed path 114 may, for example, connect to individual antenna feed horns to direct spot beam coverage to distinct terrestrial cells. The feed paths 112-114 may also be
10 characterized by a polarization effect on the waveform that propagates along the feed paths 112-114, including clockwise or counter clockwise circular polarization.

The waveform generator 106 accepts baseband data
15 from the data source 104 and creates a waveform to be transmitted (after amplification by the power amplifier 108). The switch 110 selects the particular feed path 112-114 along which the waveform propagates (and thus, in certain embodiments, the polarization
20 and/or hop location associated with the waveform).

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The controller 102 exercises beam hopping and power gating control over the waveform to be transmitted. Thus, the controller 102 may output a power gating signal that is active when selected
5 downlink frame signals are to be power gated. More particularly, as explained below, the controller 102 may power gate entire frames based in part on the current hop location for a downlink beam and other criteria.

10 With regard to Figure 2, a more specific implementation of a power gating module 200 is shown. The power gating module 200 includes a data scheduler 202, a data router 204, and a waveform processing chain including a QPSK modulator 206, an upconverter
15 208, and a traveling wave tube amplifier (TWTA) 210. The switch 110 is illustrated in Figure 2 as a ferrite switch 110 that directs the waveform to be transmitted through either the first feed path 112 or the second feed path 114.

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Figure 2 also shows a control output 216 (that may used to carry, as examples, a power gating signal and a beam hopping selection signal), two frequency selection inputs 218 and 220 for the modulator 206, a feed path selection input 222, and an intermediate waveform output 224 from the modulator. Preferably, additional ferrite switches 212 and 214 in the feed paths 112, 114 provide additional signal isolation (e.g., approximately 20db between input and output when the ferrite switch is off). In other words, the additional ferrite switches 212, 214 operate in response to the control output 216 to pass or block a waveform to be transmitted through the feed paths 112, 114. In other words, when the waveform to be transmitted is destined for the feed 112, then the ferrite switch 214 is coupled through the load 228 to ground. Similarly, when the waveform to be transmitted is destined for the feed 114, then the ferrite switch 212 is coupled through the load 226 to ground.

- 10 -

During operation, the power gating module 200 accepts baseband data from the router 204 (e.g., an ATM cell router), and creates a waveform to be transmitted using the waveform processing chain. The waveform processing starts by directly converting baseband I and Q data to an intermediate frequency of, for example, 750 MHz. The waveform processing then selects one of F1 (e.g., 3.175 MHz) and F2 (e.g., 3.425) and one of F3 (e.g., 16 GHz) and F4 (e.g., 17.4 GHz) to produce a waveform to be transmitted with a final center frequency at one of 18.425 GHz, 18.675 GHz, 19.825 GHz, and 20.075 GHz. The scheduler 202 monitors the propagation of data through the waveform processing chain and determines when certain frame signals should be power gated. To that end, the scheduler 202 provides a power gating signal on the control output 216 that is active when power gating is to occur.

The TWTA 210 amplifies the waveform to be transmitted, while the switch 110 determines along

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which feed path 112-114 (or additional feed paths) the amplified waveform will propagate. For this reason, the switch 110 includes the feed path selection input 222 responsive to information on the control output 216. Because the feed paths 112-114 are generally (though not necessarily) associated with feed horns that produce spot beams in geographically distinct terrestrial cells, the feed path selection input acts to determine the hop location of downlink frames. Thus the downlink manifests itself as a spot beam that, typically, provides bandwidth for multiple terrestrial cells by hopping between them. The hop locations below are designated Even or Odd, but are not restricted to even or odd frames. Instead Even and Odd generally designate mutually exclusive time periods.

Turning next to Figure 3, that figure shows an implementation of the modulator 206 that supports power gating. Inphase data is supplied to the Inphase gate 302 while Quadrature data is supplied to the Quadrature gate 304. As illustrated, the Inphase

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and Quadrature gates 302, 304 are D flip flops with reset inputs. The Inphase and Quadrature gates 302, 304 feed a digital modulator core 306 that produces a modulated waveform on a modulator output 308. A local
5 oscillator (LO) signal (preferably 750 MHz) provides an intermediate frequency carrier signal. The amplifier 310 boosts the modulated waveform, after which it is filtered by the bandpass filter 312. The bandpass filter 312 preferably has a passband centered
10 at 750 MHz, for example, from 625 to 875 MHz.

A data clock 314 that preferably runs at 196.7 MHz drives the Inphase and Quadrature gates 302, 304. Note that a power gate input 316 connects to the Inphase and Quadrature gates 302, 304, as well as to
15 the gating control input 318 of the digital modulator core 306. When an active power gating signal is present on the power gate input 316, the Inphase and Quadrature gates 302, 304 have their outputs held in a known state (e.g., both 0). Furthermore, the digital
20 modulator core 306 outputs a signal with frequency

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content outside of the passband of the bandpass filter
312.

For example, the digital modulator core 306 may
output a DC signal in response to the active power
5 gating signal. As a result, the bandpass filter
eliminates the DC signal. A power gated signal
results.

Returning to Figure 2, the upconverter 208 (e.g.,
a 20 GHz mixer) ordinarily outputs a fully upconverted
10 signal for amplification and transmission. However,
the absence of energy in the power gated signal causes
the upconverter to produce substantially no signal at
its output during power gating. As a result, the TWTA
210 does not expend amplification energy, and
15 substantially no downlink energy is present in the
downlink beam while the power gating signal is active.

Turning next to Figure 4, that figure presents a
timing diagram 400 that illustrates a multiple payload
frame signal 402 and power gating signals 404, 406,
20 408, 410, 412, 414, 416 (assumed active when high).

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As an example, the frame signal 402 may include a 368-symbol first header signal 418, a 7552-symbol first payload signal 420, a first 16-symbol flush signal 422, a 96-symbol second header signal 424, a 7552-symbol second payload signal 426, and a second 16-symbol flush signal 428. In general, however, the frame signal 402 may include N headers and N payloads independently subject to power gating.

The power gating signal 404 never goes active during the frame signal 402. Thus, none of the frame signals 418-428 are power gated. As a result, both first and second header signals 418, 424, both first and second payload signals 420, 426, and both first and second flush signals 422, 428 are delivered to the ground. In contrast note that the power gating signal 416 is active across the entire frame signal 402. Thus, substantially no energy is provided in the downlink beam over the time during which the frame signal 402 would be transmitted.

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On the other hand, the power gating signal 406 goes active during the second payload signal 426 and the second flush signal 428. Thus, the frame signal 402 continues to bear important overhead information in the first and second header signals 418, 424. The overhead information may include, for example, synchronization bits, beam hopping location identifiers, frame coding identifiers, frame counts, and the like.

The overhead information may further include power gating bit patterns that indicate to a ground receiver which frame signals are power gated. As an example, the first header signal 418 or second header signal 424 may include a frame type field that carries repetitions of the bit pattern 10100101 to indicate power gating of the first payload signal 420 or second payload signal 426, or repetitions of the bit pattern 11110000 to indicate power gating of the entire frame signal 402. In particular, bit patterns may be assigned to identify any combination of header,

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payload, and flush signal power gating. Note also
that a ground receiver may deactivate its own
receivers in response to the bit patterns, in order to
save power during power gated sections of the frame
5 signal.

Still with reference to Figure 4, the power
gating signal 410 results in power gating of the first
and second payload and flush signals 420, 422, 426,
428. Similarly, the power gating signal 412 results
10 in power gating of the first payload signal 420 and
the first flush signal 422.

Because the multiple payload frame signal 402
includes multiple headers, each preferably bearing
synchronization information, additional power gating
15 options are available. Thus, for example, the power
gating signal 408 power gates the second header signal
424, second payload signal 426, and the second flush
signal 428. Synchronization is nevertheless provided
by the first header signal 418. Similarly, the power

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gating signal 414 power gates all the frame signals except for the first header signal 418.

The scheduler 202 may include logic to assert the power gating signal under many scenarios. For example, when the satellite moves into eclipse and less power is available, the scheduler 202 may power gate every second complete frame, every second payload, or any combination of frame signals to achieve a desired power reduction. As another example, the scheduler 202 may activate the power gating signal in response to a statistical multiplexing estimate of downlink beam utilization. As an example, if the downlink beam is estimated to be 90% utilized during a certain time period, then the scheduler 202 may power gate up to 10% of the frames or payloads. Such estimates may be generated terrestrially and uplinked to the satellite or generated onboard.

As another example, the scheduler 202 may determine when to activate power gating based on the

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current terrestrial cell hop location of the downlink beam. Thus, the scheduler 202 may power gate the second payload signal 426 if the bandwidth requirements of the current terrestrial cell are met

5 by the first payload signal 420 alone. As yet another example, the scheduler 202 may power gate based on data queues present in the router 204. For example, a data queue from which ATM data cells are extracted to fill the second payload signal 426 may consistently

10 have too few cells to completely fill the second payload signal 426. In response, the scheduler 202 may power gate the second payload signal 426 periodically in order to maintain the data queue approximately at a preselected occupancy level, on the

15 average.

Turning next to Figure 5, that figure shows a flow diagram 500 of the operational steps that occur before and after power gating. The operational steps include hopping 502 a downlink beam between at least

20 two terrestrial cells. At step 504, power gating is

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determined based on the beam hopping duty cycle. As an example, power gating may be activated to provide a power gated, variable duty cycle beam laydown, discussed below with respect to Figures 6 and 7.

5 Continuing at step 506, entire frames may be power gated. Thus, at step 508, a frame signal is transmitted only for non-power gated frames containing at least one header signal, payload signal, and flush signal while substantially no energy in the downlink
10 beam is transmitted for power gated frames.

Turning next to Figure 6, that figure illustrates a beam laydown 600. The beam laydown 600 uses beams of a first frequency and two different polarizations (1R and 1L). For example, 1R beams cover cells 602, 604, while 1L beams cover cells 606, 608. It is generally undesirable to have two adjacent, same-color (e.g., 1L) cells receiving energy simultaneously because high levels of interference between adjacent cells would result, and thus pairs of adjacent cells
15 20 are assumed to be hopped on a 50-50 hop cycle. With

- 20 -

respect to cells 606, 608, for example, spot beam energy is provided in cell 606 for half of a predetermined time period, while spot beam energy is provided in cell 608 for the other half. One of the many ways in which a 50-50 hop cycle may be implemented is to transmit a first frame to cell 606, hop to cell 608, transmit a second frame to cell 608, the hop back to cell 606. The hops need not be between adjacent cells.

While a 50-50 hop cycle may be appropriate for many cells that have equal bandwidth needs, certain cells may need additional bandwidth. Turning next to Figure 7, that figure shows a variable hop cycle beam laydown 700 (specifically implemented for the 1L beams). The beam laydown 700 uses power gating to allow different hop cycles between cells, eight of which are identified in Figure 7 as cells A-H. For each cell, the portion of a hop cycle during which downlink beam energy is transmitted to that cell is indicated in Figure 7 by cross-hatching.

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Cells A and B, C and D, E and F, and G and H are hop pairs. Cells A and H benefit from increased bandwidth (and may correspond, for example, to large population centers such as Los Angeles and Chicago).

5 To that end, cells A and B are on a 75-25 hop cycle, as are cells G and H. Cells C and D are on a default 50-50 hop cycle. In order to transition from the 50-50 hop cycle of cells C and D to the 75-25 hop cycle of cells G and H, the transition cells E and F hop at
10 a 50-25 transition hop cycle with power gating to prevent any adjacent cells from having 1L downlink beam energy at the same time.

The transition cells E and F (because of the 50-25 transition hop cycle) are interfering minimally
15 with the adjacent cells. Minimization of interference may be gauged by the separation of cells by one or more beam color components including frequency and polarization. Note also that hop pairs need not be adjacent. For example, referring again to Figure 7,

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cells C and I may be hop pairs, and cells D and J may be hop pairs.

In other words, cell E has downlink beam energy half the time, cell F has downlink beam energy 25 percent of the time, and the remaining time the downlink frames are power gated. One way in which this may be implemented is shown in the hop table below (Table 1). In Table 1, a 'T' indicates transmission of downlink beam energy for a cell, 0 indicates a time during which the beam has been hopped to a different cell, and G indicates that all or part of a frame has been power gated.

Table 1								
	Time 1	Time 2	Time 3	Time 4	Time 5	Time 6	Time 7	Time 8
Cell A	T	T	T	0	T	T	T	0
Cell B	0	0	0	T	0	0	0	T
Cell C	T	0	T	0	T	0	T	0

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Cell D	0	T	0	T	0	T	0	T
Cell E	T	0	T	0	T	0	T	0
Cell F	0	T	0	G	0	T	0	G
Cell G	0	0	0	T	0	0	0	T
Cell H	T	T	T	0	T	T	T	0

Table 1 specifies that cell A (e.g., covering Los Angeles) receives energy at times 1, 2, and 3. Each time may represent a single frame or a set of N frames, as examples. In other words, over a time period of 4 frames, cell A receives downlink beam energy 75 percent of the time period (in order to deliver three frames to cell A). Cell B receives energy at time 4, or 25 percent of the time period (in order to deliver a single frame to Cell B). Similarly, cell C receives energy at times 1 and 3 and cell D receives energy at times 2 and 4.

Cell G receives energy at time 4 while cell H (e.g., Chicago) receives energy at times 1, 2, and 3.

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The transitions cells E and F are configured, like the other cells, to avoid simultaneous transmission of energy to adjacent cells. One way in which this may be done is to deliver energy to cell E during times 1 and 3, to deliver energy to cell F during time 2, and power gate the downlink frame in cell F during time 4 (the remaining time period). Thus, although a fraction of the downlink bandwidth is power gated in cell F, a transition is made from a 50-50 hop cycle to a 75-25 hop cycle to support the bandwidth demands of cell H, while keeping interference between cells to a minimum.

The entries in the hop table may be supported by a memory in the scheduler 202. In particular, before each frame is transmitted, the scheduler 202 retrieves a frame header from the downlink scheduling table. The frame header preferably specifies a 3-bit beam A type and a 3-bit beam B type, where beam A refers to a first hop location in a hop pair (e.g., cell A) and beam B refers to a second hop location in the hop pair

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(e.g., cell B). Table 2 illustrates exemplary beam type bit pattern definitions.

Table 2	
Bit pattern	Beam type
000	power gate
001	frame gate
010	disable beam
011	heavy coding frame
110	light coding frame

Thus, a 000 beam type indicates that a payload in
5 a frame should be power gated, a 001 beam type
indicates that the entire frame should be power gated,
and a 010 beam type indicates that the beam is
disabled. Because energy is not provided in hop pairs
simultaneously, either beam A or beam B is always
10 disabled under ordinary circumstances.

A beam may hop between more than two cells. To
that end, the frame header may be extended to include
beam type definitions for additional beams.

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Thus, the present invention provides selective power gating of frame signals in a beam hopped multiple payload downlink frame. The power gating may be used to implement variable hop cycles in a beam
5 laydown to deliver bandwidth where it is most needed. Changes in bandwidth demand may be met on a dynamic basis even after the satellite is launched.

Note also that the hop cycles are not restricted to 50-50 or 25-75. Rather, because frames may be sent
10 to selected hop locations on a frame by frame basis, the hop cycles may be set to any desired ratio by hopping frames appropriately.

While the invention has been described with reference to a preferred embodiment, those skilled in
15 the art will understand that various changes may be made and equivalents may be substituted without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular step, structure, or material to the
20 teachings of the invention without departing from its

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7 beam energy comprises transmitting downlink beam
8 energy for a transition hop pair.

1 3. The method of claim 1, wherein transmitting
2 transition downlink beam energy comprises transmitting
3 power gated downlink frames.

1 4. The method of claim 1, wherein each
2 transmitting step comprises transmitting at at least a
3 first frequency and first polarization.

1 5. The method of claim 1, wherein transmitting
2 second downlink energy comprises transmitting second
3 downlink beam energy according to a second hop cycle
4 that provides additional bandwidth to meet bandwidth
5 needed for one of the second cells.

1 6. The method of claim 1, further comprising
2 the step of reading frame headers that define the
3 first hop cycle, second hop cycle, and transition hop
4 cycle.

1 7. A variable hop cycle beam laydown
2 comprising:

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1 16. The laydown of claim 7, wherein at least one
2 of the first, second, and transition cells are
3 adjacent cells.

1 17. Apparatus for generating a variable hop
2 cycle beam laydown, the apparatus comprising:

3 a waveform generator producing a first downlink
4 beam, second downlink beam, and a transition downlink
5 beam;

6 at least one switch directing the first downlink
7 beam between first feed paths to first cells,
8 directing the second downlink beam between second feed
9 paths to second cells, and directing the transition
10 downlink beam between third feed paths to transition
11 cells;

12 at least one feed path selection input coupled to
13 the at least one switch; and

14 a memory for storing downlink beam type
15 definitions that direct the feed path selection input
16 to control the switch according to a first hop cycle,

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17 a second hop cycle different than the first hop cycle,
18 and a transition hop cycle.

1 13. The apparatus of claim 17, further
2 comprising a power gating circuit coupled to the
3 waveform generator for gating power in the transition
4 downlink beam.

1 19. The apparatus of claim 18, wherein the
2 first, second, and transition downlink beams comprise
3 frames with a header field and a payload field.

1 20. The apparatus of claim 17, wherein the first
2 hop cycle directs additional bandwidth to one of the
3 first cells to meet bandwidth need.

1 21. The apparatus of claim 20, wherein the first
2 hop cycle is a 75-25 hop cycle.

1 22. The apparatus of claim 21, wherein the
2 second hop cycle is a 50-50 hop cycle and wherein the
3 transition hop cycle is a 75-25 hop cycle.

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Beam Laydown for Hopped Satellite Downlink with
Adaptable Duty Cycle

ABSTRACT OF THE DISCLOSURE

A power gated variable hop cycle beam laydown
5 (700) manifests itself as first cells (C, D) supported
by a first hop cycle, second cells (G, H) supported by
a second hop cycle, and transition cells (E, F)
supported by a transition hop cycle. The transition
hop cycle uses power gating to transition the laydown
10 (700) from cells (C, D) operating at the first hop
cycle to cells (G, H) operating at the second hop
cycle. To this end, the transition hop cycle power
gates its downlink beam for a portion of time needed
to reduce interference between nearby (e.g., adjacent)
15 cells.

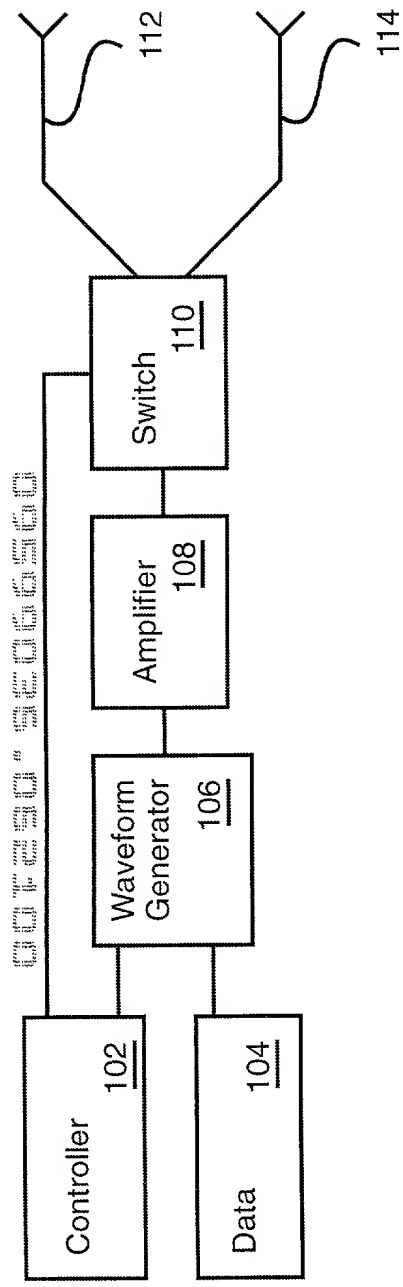


Figure 1

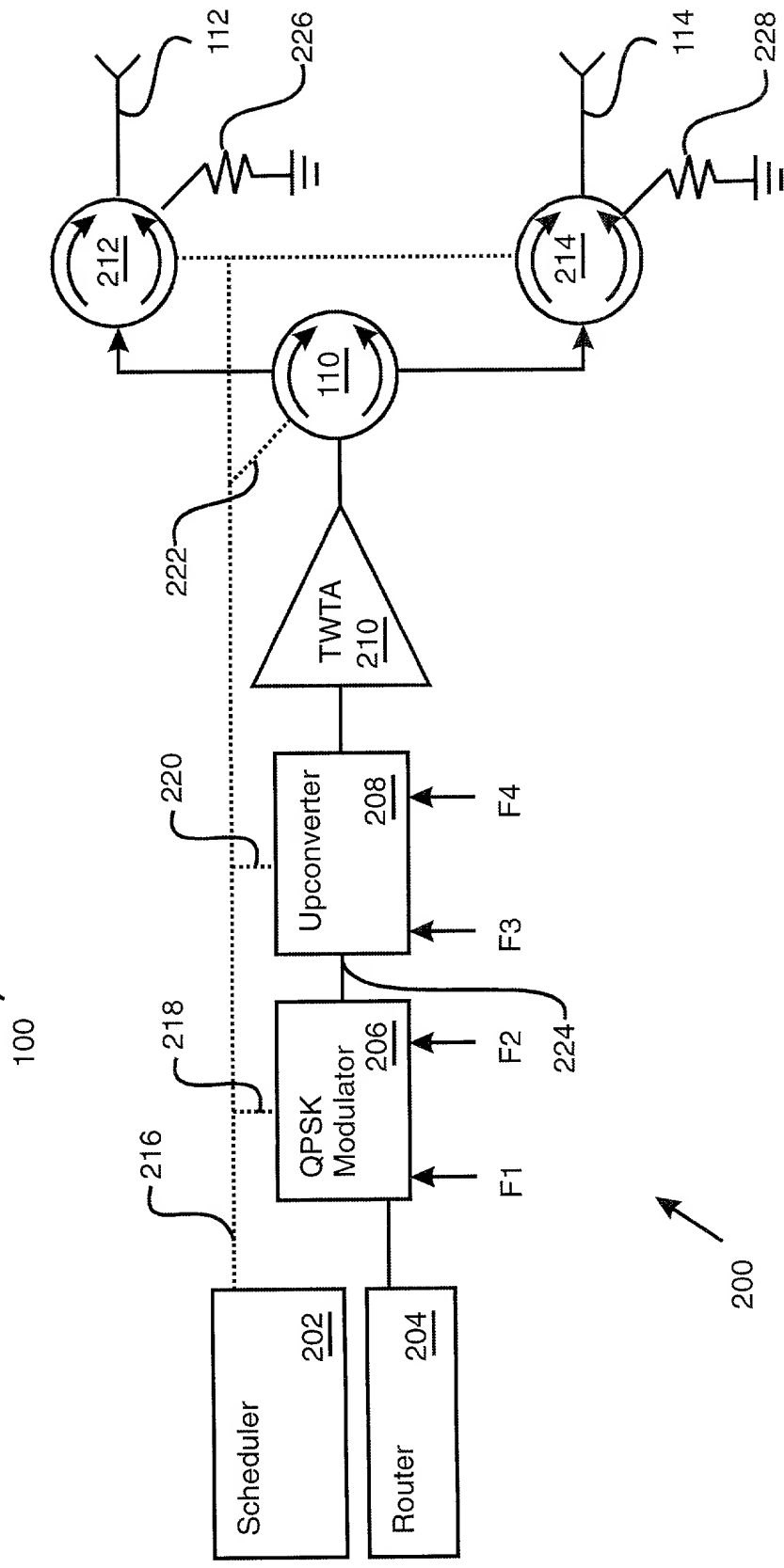


Figure 2

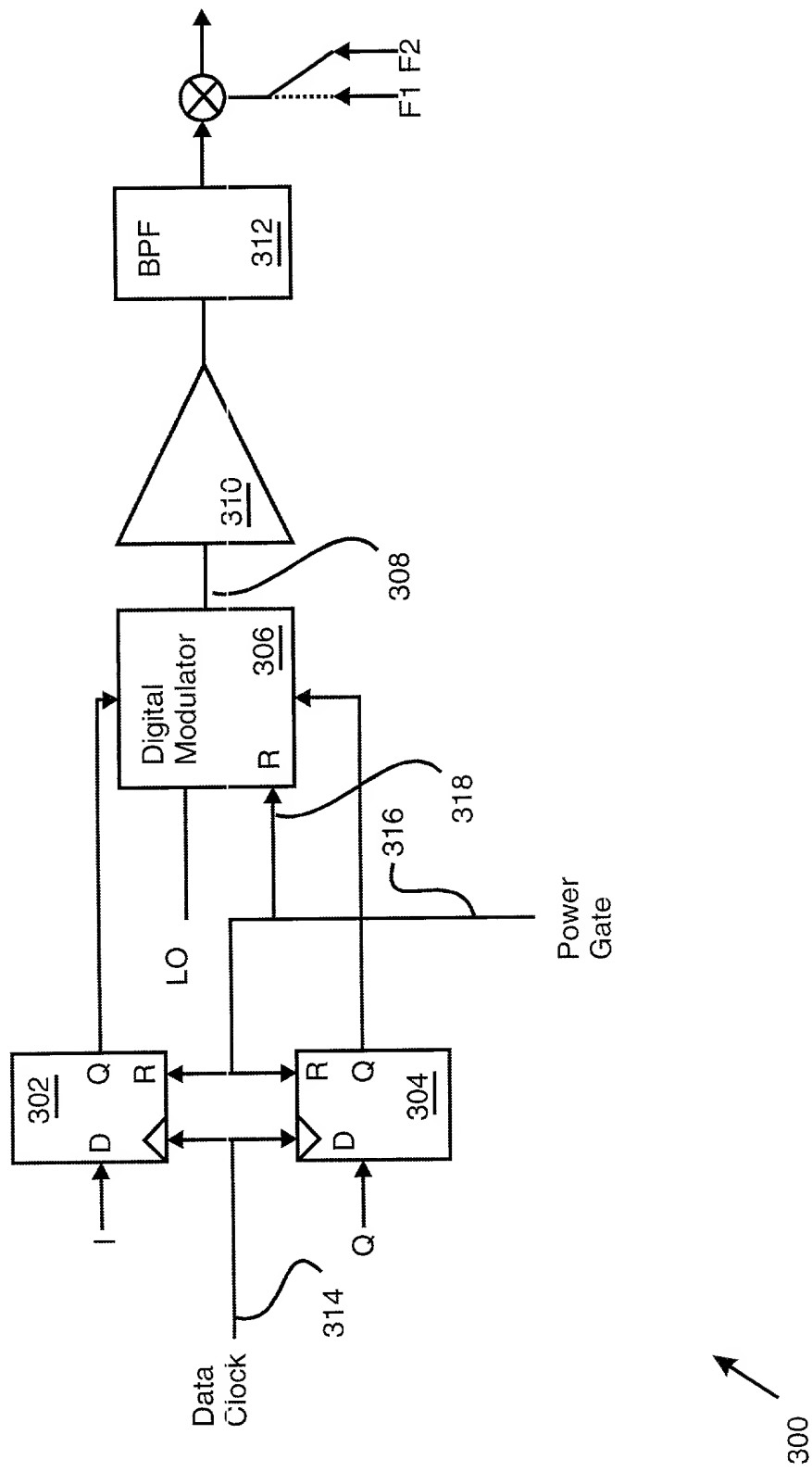


Figure 3

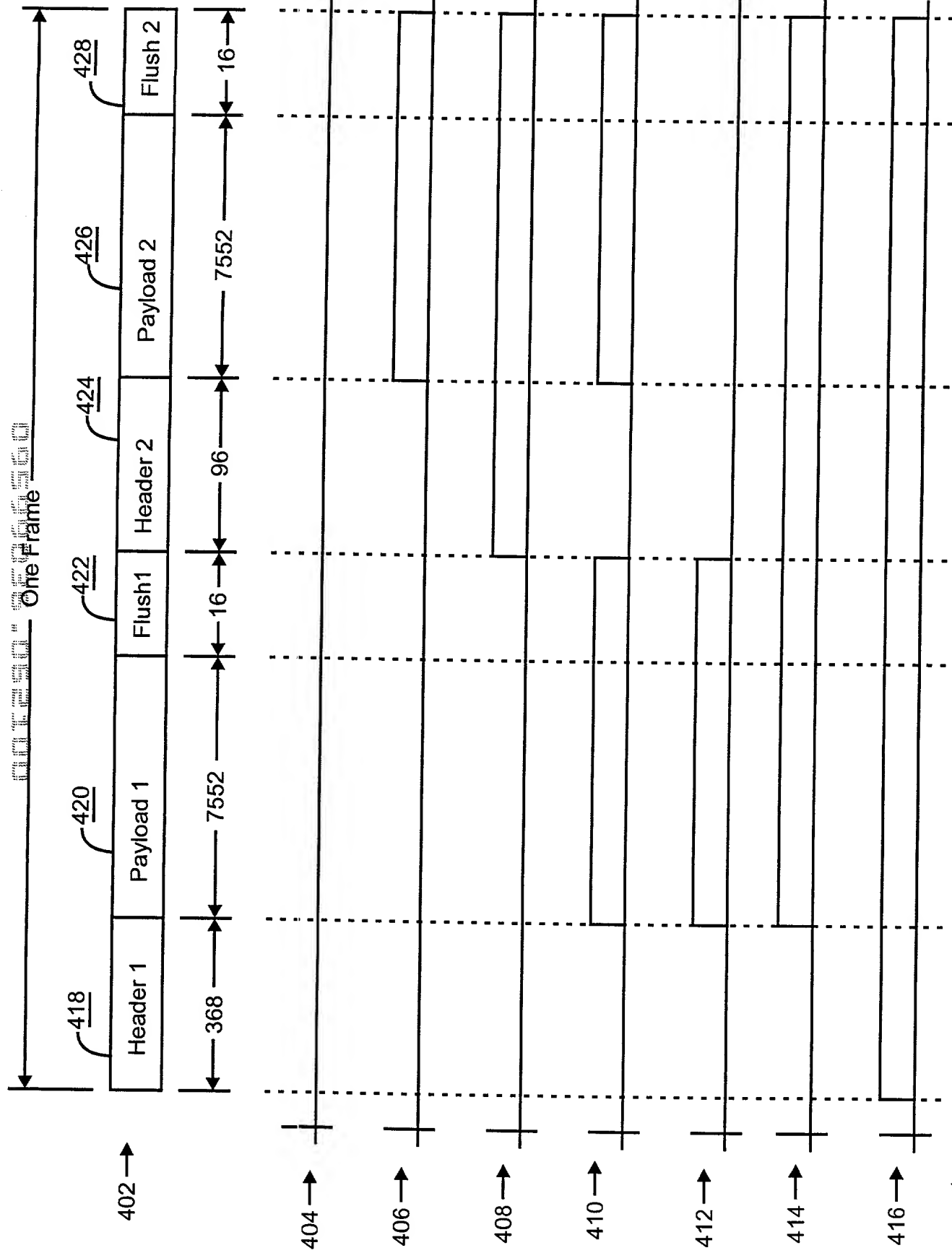
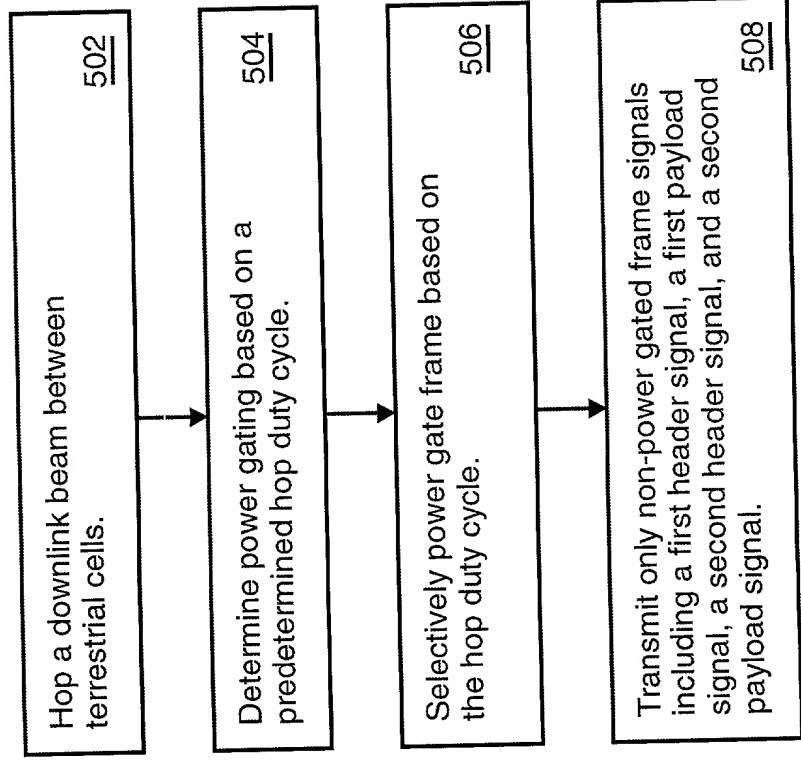


Figure 4



500

Figure 5

The diagram shows a hexagonal lattice of 25 cells arranged in a 5x5 grid. The cells are labeled alternately as '1L' and '1R'. Two arrows point to specific cells: one labeled '602' points to a '1R' cell, and another labeled '606' points to a '1L' cell. Other labels include '604' and '608' near the bottom right.

Figure 6



Figure 7

DECLARATION FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled BEAM LAYDOWN FOR HOPPED SATELLITE DOWNLINK WITH ADAPTABLE DUTY CYCLE the specification of which

_____ is attached hereto

_____ was filed on _____ as Application Serial No. _____ and was amended on _____ (if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)

Priority Claimed

<u>NONE</u> (Number)	<u> </u> (Country)	<u> </u> (Day/Mo./Yr. Filed)	<u> </u> Yes	<u> </u> No
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Docket No. 22-0134

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

<u>NONE</u> (Number)	<u> </u> (Country)	<u> </u> (Day/Mo./Yr. Filed)	<u> </u> (Status)
-------------------------	--	--	---

I hereby appoint as principal attorneys:

Robert W. Keller, Reg. No. 25,347
Michael S. Yatsko, Reg. No. 28,135
Connie M. Thousand, Reg. No. 43,191
William M. Wesley, Reg. No. 26,521

each with full power to prosecute this application, to transact all business in the United States Patent and Trademark Office connected therewith, and to appoint and revoke associate and substitute associate attorneys.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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